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Chia et al.

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(54) **MODULAR CABLE MANAGEMENT SYSTEM**

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(51) **Int. Cl.**

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F16L 3/127	(2006.01)
H02G 3/02	(2006.01)
H05K 7/18	(2006.01)

(52) **U.S. Cl.**
CPC ***F16L 3/127*** (2013.01); ***H02G 3/02*** (2013.01); ***H05K 7/18*** (2013.01)

(58) **Field of Classification Search**
CPC H04Q 1/062; H05K 7/1491; H01B 7/40
USPC ..... 174/100, 99 R; 361/826; 385/135
See application file for complete search history.

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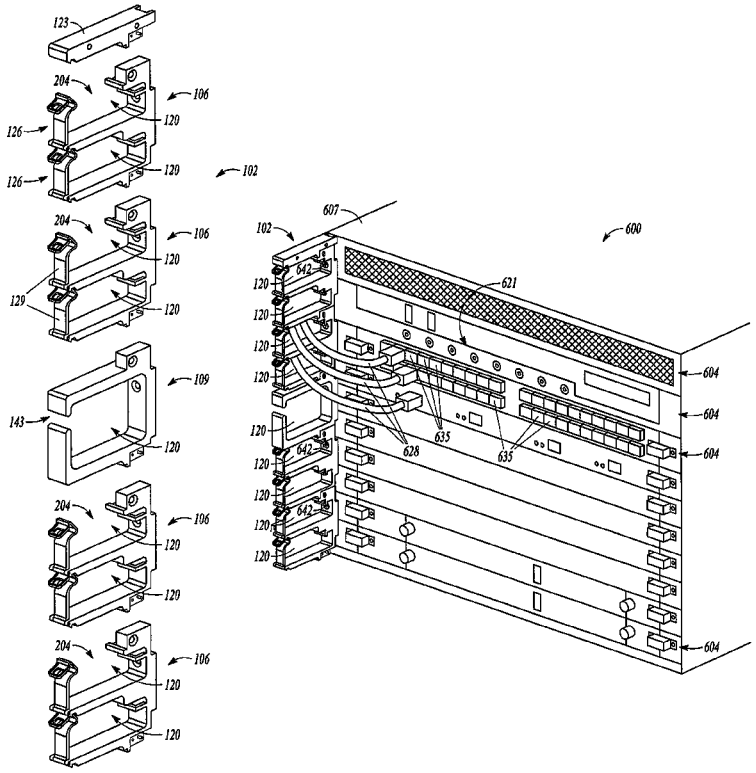
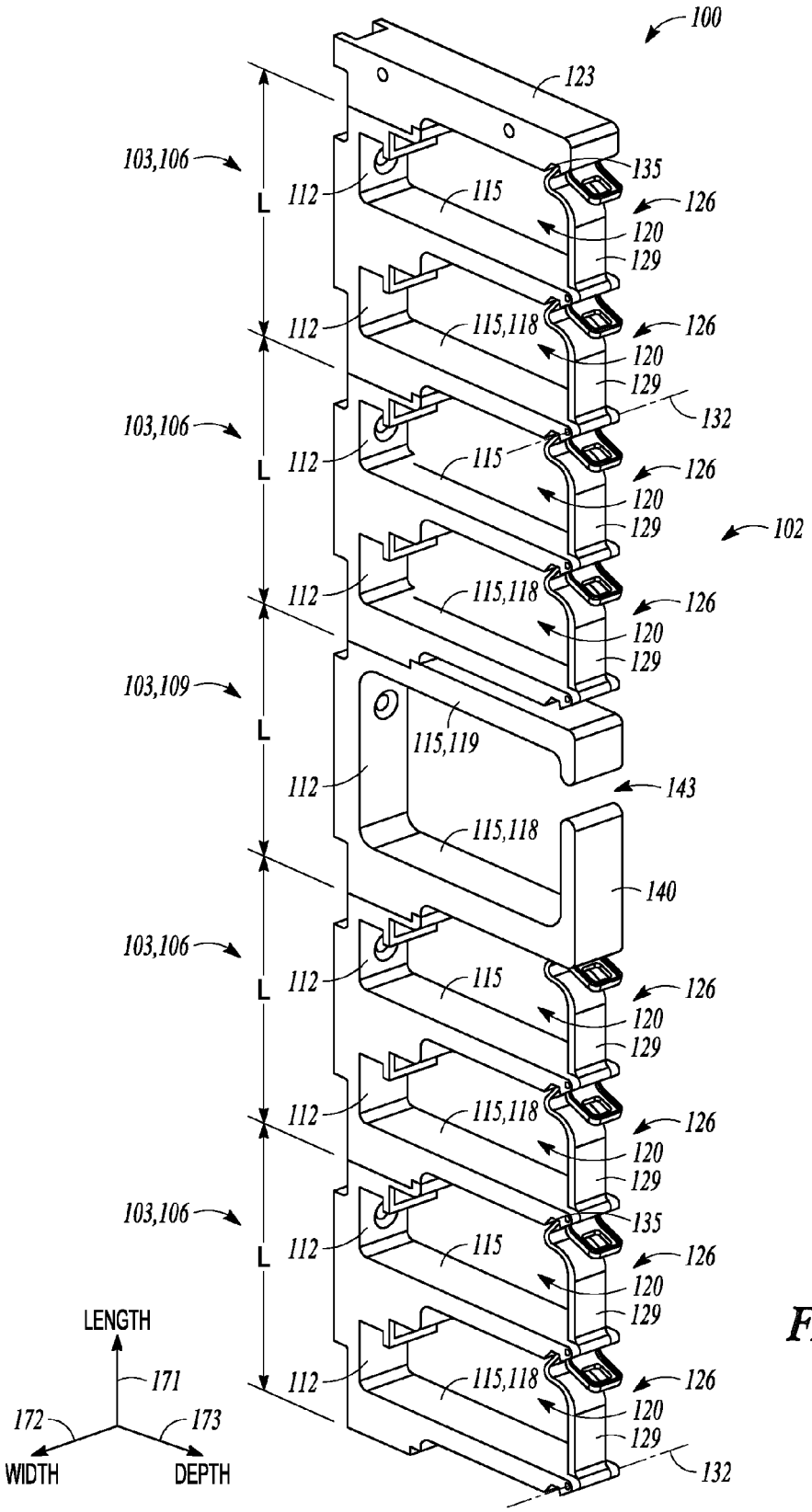
(57) **ABSTRACT**

A set of modular bracket units are mountable end-to-end in series on a support structure adjacent a cable interface area of an electronic equipment assembly, the form a composite cable management bracket. The bracket units are mountable in interchangeable positions in the series to define longitudinally extending series of segregated cable management openings through which cables are receivable for connection to respective electronic equipment ports, to restrain the cables against transverse escape from the respective cable management openings. The set of modular bracket units comprises at least one single-opening bracket unit that defines a single cable management opening, and at least one multi-opening bracket unit that defines, when mounted as part of the composite cable management bracket, two or more cable management openings. The bracket units that define different numbers of cable management openings are of equal modular length and has identical connection formations, to allow mounting of the bracket units in any desire sequence.

17 Claims, 7 Drawing Sheets

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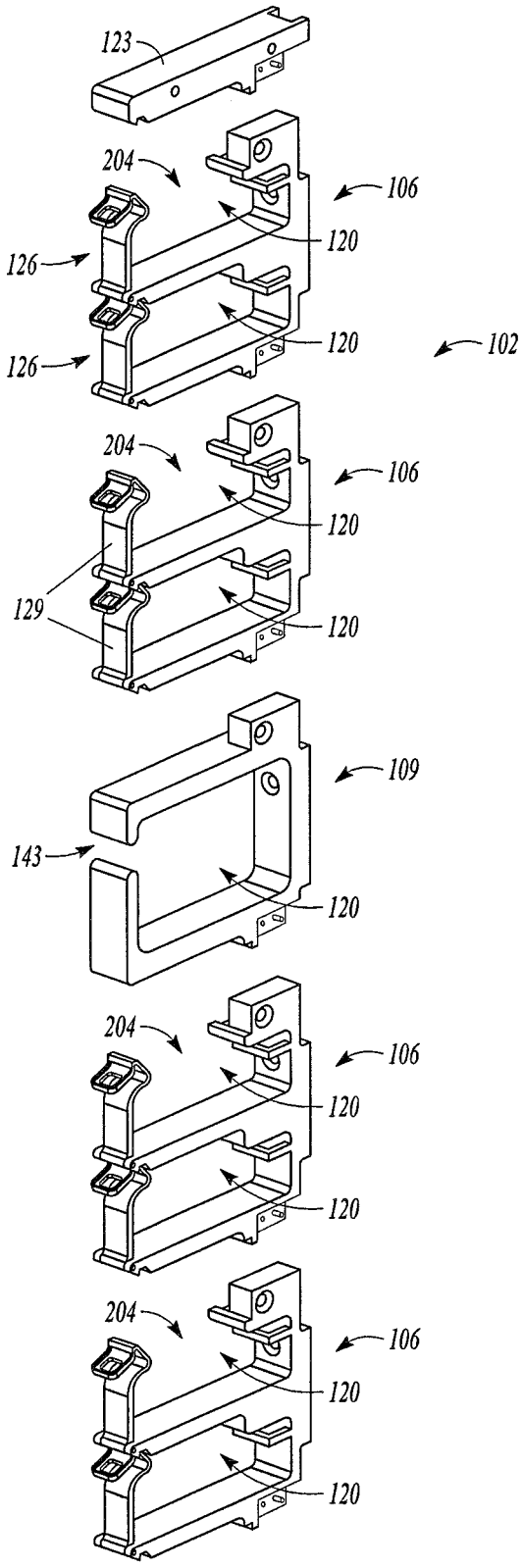
123
103,106
135
112
115
126
120
129
115,118
132
102
103,109
115,119
143
140
LENGTH
171
172
173
WIDTH
DEPTH

FIG. 1


123
204
106
120
126
120
102
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109
143
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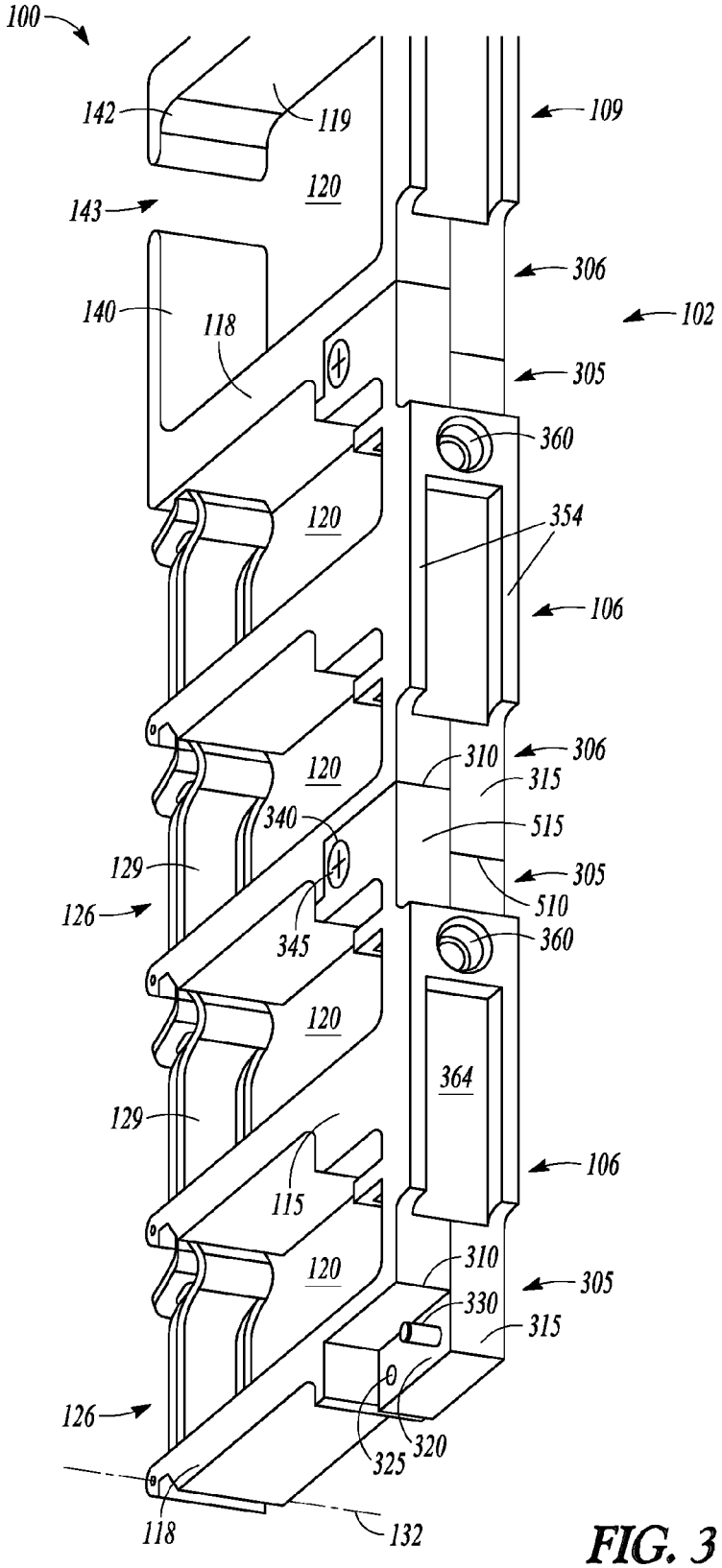
204
106
120
120
204
106
120
120

FIG. 2


100
142
119
109
120
143
306
140
118
102
305
360
120
354
106
120
310
306
315
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515
129
305
126
510
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129
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115
120
310
305
330
315
126
320
325
118
132

FIG. 3

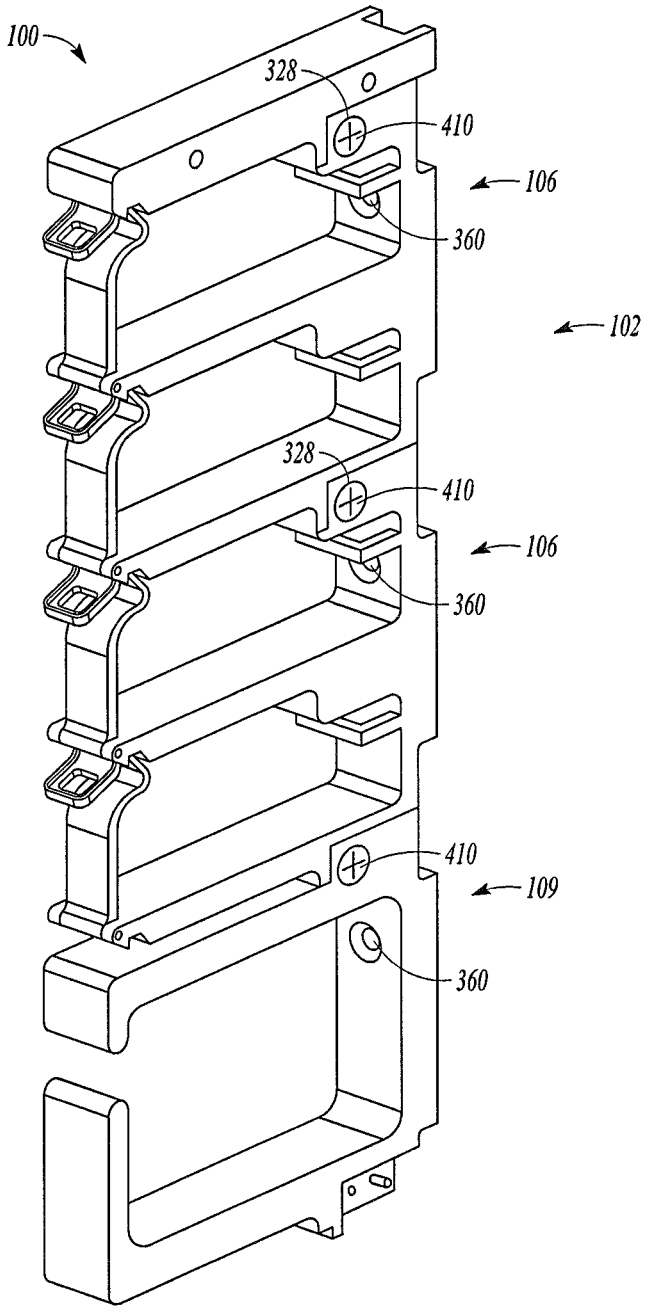

FIG. 4

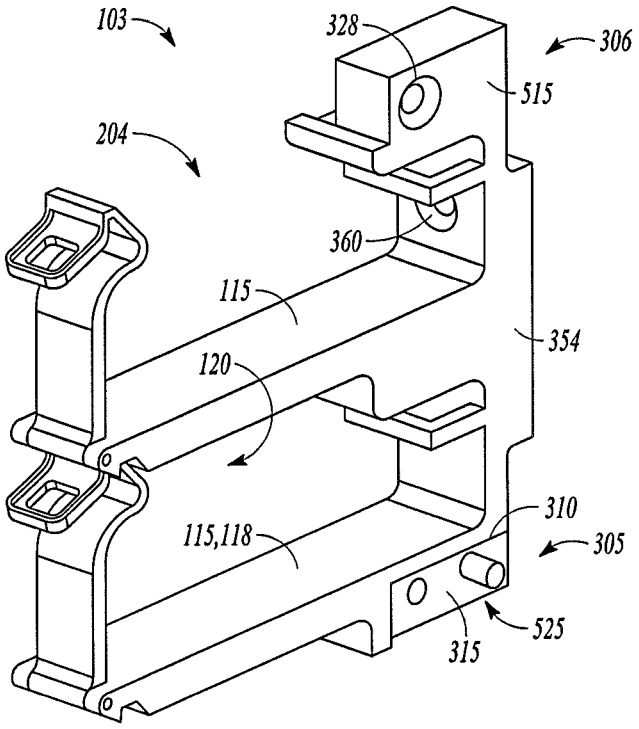

FIG. 5

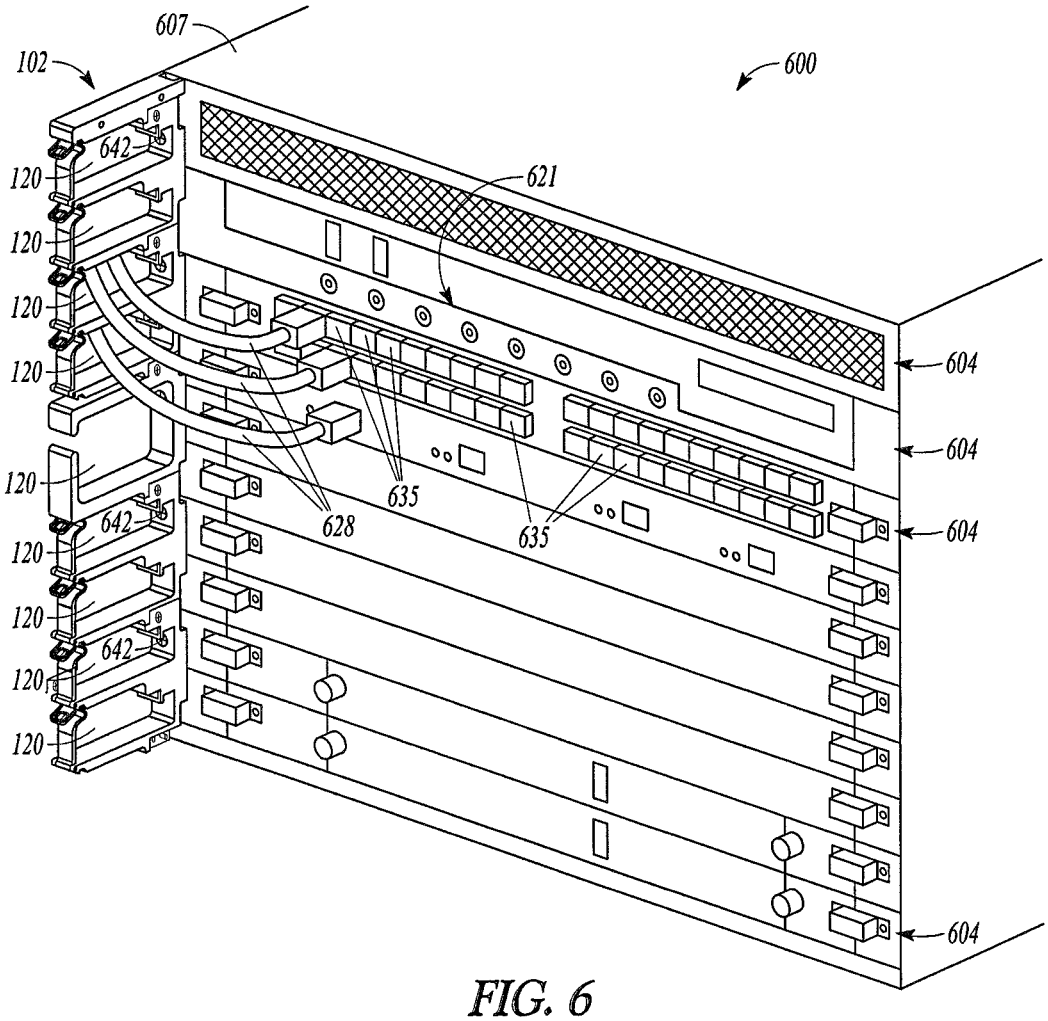
607
102
600
642
120
120
120
120
621
604
604
604
120
642
120
120
642
120
120
635
628
635
604

FIG. 6

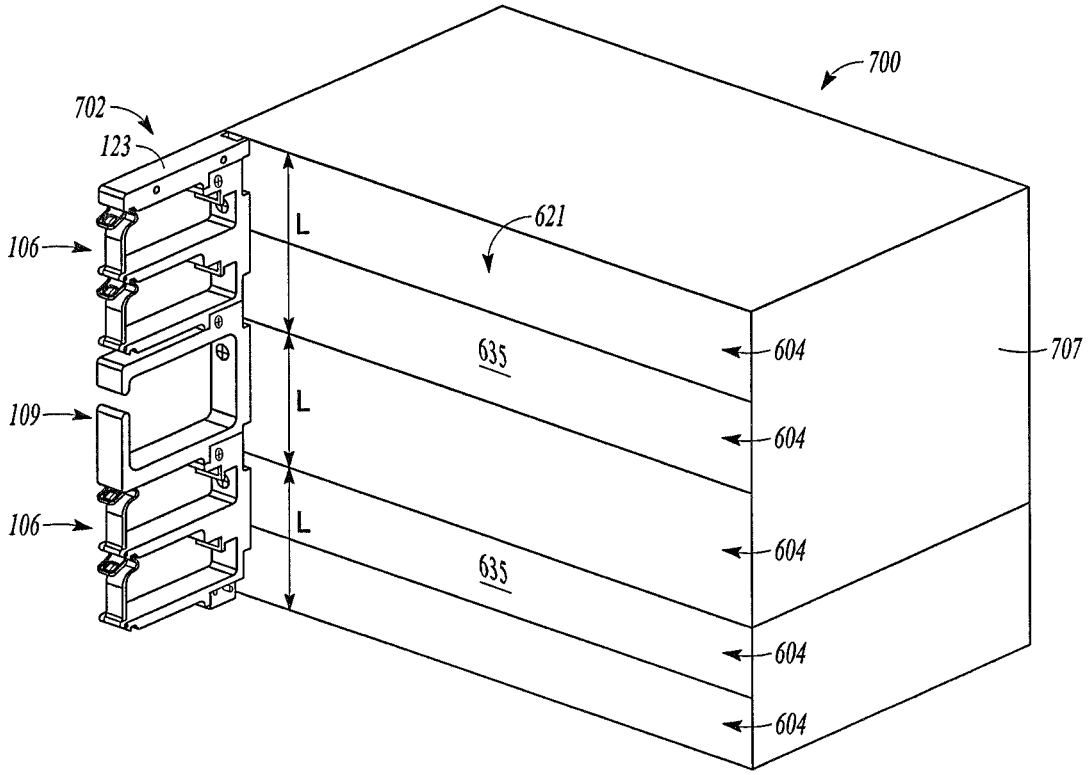

FIG. 7

MODULAR CABLE MANAGEMENT SYSTEM

TECHNICAL FIELD

The present disclosure relates generally to electronic equipment and more particularly to methods and systems for management of cables in electronic equipment, and to components of such cable management systems.

BACKGROUND

Electronic equipment is often designed in accordance with standardized dimensional parameters, for example being shaped and dimensioned for reception in standard sized racks. Such racks typically include upright supports separated by an opening. The opening widths of racks tend to be standard sized, as adopted by industry, manufacturers, and/or governments. In the United States, for example, telephone companies may use racks having opening widths of 23 inches, whereas telephone companies in European countries may use racks having opening widths of 19 inches.

Rack mountable electronic equipment may take the form of modular electronic equipment. Often, modular electronic equipment is installed into a chassis and the chassis is then mounted in the opening of a rack. In the case of modular communication equipment, a chassis may house optical electronic equipment such as transmitters, receivers, intelligent control interface modules, power supplies, and the like. A chassis may also house cooling fans or other cooling mechanisms to aid in controlling the operating temperature of the equipment modules.

In a common scenario, an electronic equipment module slides into a slot (or slots) in the chassis and connects at one end to a chassis backplane defining a cable interface area that has mating communication connectors to receive the module. Cables may route to and through the chassis. Once the modules are installed into the slots they are typically wired to other electronic modules that may or may not be located in the same rack.

Cable management brackets are sometimes mounted on the chassis adjacent the cable interface area to route cables, e.g. in bundles, and/or to segregate cables connecting to different modules.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are not necessarily drawn to scale, like numerals may describe similar components in different views. Like numerals having different letter suffixes may represent different instances of similar components. Some embodiments are illustrated by way of example, and not limitation, in the figures of the accompanying drawings in which:

FIG. **1** is a schematic, three-dimensional front view, taken from above, of a set of bracket units to form a composite cable management bracket, when mounted, in accordance with an example embodiment.

FIG. **2** is an exploded three-dimensional view of the set of bracket units of FIG. **1**, in according to an example embodiment.

FIG. **3** is a three-dimensional rear view, taken from below, of a set of bracket units according to an example embodiment.

FIG. **4** is a three-dimensional front view, taken from above and from an opposite side to the view of FIG. **1**, of a set of cable management bracket units according to an example embodiment.

FIG. **5** is a three-dimensional view of a bracket unit to form part of a set of bracket units for forming a composite cable management bracket, when mounted on a support element associated with electronic equipment, according to an example embodiment.

FIG. **6** is a three-dimensional schematic view of an electronic equipment system that comprises a composite cable management bracket mounted on a chassis of an electronic equipment module according to an example embodiment.

FIG. **7** is a three-dimensional schematic view corresponding to FIG. **6**, showing bracket units of the composite cable management bracket being mounted on a different electronic equipment module and in a different arrangement.

DETAILED DESCRIPTION

The following description and the drawings sufficiently illustrate specific embodiments to enable those skilled in the art to practice and/or implement the disclosed systems, methods, and/or apparatuses. Other embodiments may incorporate structural, operational, and other changes. Portions and features of some embodiments may be included in, or substituted for, those of other embodiments.

In FIG. **1**, numeral **100** generally indicates a set of bracket units **103** to form a composite cable management bracket **102** for electronic equipment, according to an example embodiment. The bracket unit set **100** is shown, for ease of illustration, FIGS. **1-5** in isolation, without being mounted on a support member such as a chassis of an electronic equipment module (see FIGS. **6** and **7**). Note that the assembled bracket units **103** form a composite bracket **102** only when mounted on such a support structure, the isolated assembled bracket unit set **100** shown in FIGS. **1** and **3-5** is, for ease of description, referred to, inter alia, as the composite bracket **102**.

The bracket unit set **100**, in this example, comprises five bracket units **103**, made up of four double-opening bracket units **106** and one single-opening bracket unit **109**. As discussed in the description that follows, the bracket units **103** are shaped and dimensioned to provide modular components that can be mounted end-to-end in series (in relative spatial arrangement similar or analogous to that of FIG. **1**), to form the composite cable management bracket **102** that provides a series of cable management openings **120** along its length. These cable management openings **120** serve to hold captive cables for different electronic equipment modules, segregating the cables to facilitate cable management by operators and supporting the weight of the cables to shield port connections of the cables to the electronic equipment modules from exposure to the cables' full weight.

Each of the bracket units **103** includes a base formation **112** that is elongate and, when the composite bracket **102** is assembled, are longitudinally aligned to provide a composite spine that runs along the length of the composite bracket **102**. The base formation **112** defines mounting formations (discussed later with reference, e.g., to FIG. **3**) for mounting the bracket unit **103** on the support structure such that the base formation **112** is anchored to and bears against the support structure.

Each of the double-opening bracket units **106** includes a pair of limbs or fingers **115** that project substantially perpendicularly away from the base formation **112**, cantilever-fashion. The length of the fingers **115** determines a depth of the associated bracket unit **103**. Because all the fingers **115** are of substantially equal length, the composite bracket **102** has a substantially constant depth dimension along its length.

Note that, for clarity of description, FIG. **1** shows a set of orthogonal axes that illustrate the directions associated with

respective dimensions referred to in this description. Thus, a length **171** of the composite bracket **102** is defined by the composite spine formed by the aligned base formations **112**, in the example of FIG. **1** being upright. A depth **173** of the composite bracket **102** is normal to the length of the composite bracket **102**, in use projecting substantially perpendicularly away from a plane of a cable access opening (see FIGS. **6** and **7**) next to which the composite bracket **102** may be mounted. In this example, the depth of the composite bracket **102** is determined by the distance by which the fingers **115** project away from the base formation **112**.

Note that the two fingers **115** of each double-opening bracket unit **106** cannot, by themselves, define the two cable management openings **120** provided in practice by each double-opening bracket unit **106**. See for example FIG. **5**, which shows a double-opening bracket unit **106** in isolation. In this example, multi-opening bracket units such as the double-opening bracket unit **106** defines, when considered separately, one cable management opening **120** fewer than is provided at the double-opening bracket unit **106** when it is mounted as part of the composite bracket **102**. In this example, each double-opening bracket unit **106** has a bottom end finger **118** at a lowermost end of the base formation **112**, with an upper end of the base formation **112** having no limb or finger projecting therefrom.

Note that references to the upright orientation of the composite bracket **102** (and therefore labeling of elements as being upper-, lower-, top-, bottom elements, and the like) in these examples are for ease of description only, and are not to be understood restrictively. Indeed, the composite bracket **102** may, in other examples, have an orientation that is not upright, for example extending horizontally above or below a cable access opening.

As can best be seen in FIG. **2**, each double-opening bracket unit **106** defines an incomplete or partial cable management opening **120** at one of its ends in the lengthwise direction of the composite bracket **102**, so that the cable management opening **120** has an operatively upper open side **204**. The partial cable management openings **120** are, however, completed by the bottom end finger **118** of the immediately adjacent bracket unit **103**, which occupies the open side **204**, closing off the cable management opening **120**. Each bottom end finger **118** (except the bottom end finger **118** of the bottommost bracket unit **103**) thus borders and separates two adjacent cable management openings **120**.

Although, as described, the cable management openings **120** thus defined by two bracket units **103** at their joint are not wholly bounded by elements of a single double-opening bracket unit **106**, these cable management openings **120** are described as being provided by the double-opening bracket unit **106** that borders the greater portion of the cable management opening **120**'s circumference. Associated terms, such as "multi-opening bracket unit," "double-opening bracket unit," and the like, are to be understood accordingly. Thus, the example double-opening bracket unit **106** does not define, on its own, more than one cable management opening **120**, but is nevertheless referred to as a "double-opening" or "multi-opening" bracket unit.

In this example, the bracket unit set **100** includes an end piece or end unit **123** that comprises a finger-like bar element to close off and complete (in this example) the uppermost cable management opening **120**.

Distal ends of the fingers **115** of the double-opening bracket units **106** define between them respective gateway gaps **126** through which lateral passage of cables into and out of the associated cable management openings **120** can be effected. In this example, each gateway gap **126** is closed by a sprung latch **129** that is mounted for hinged displacement about a hinge axis **132** parallel to the width dimension of the composite bracket **102** and located at a distal end of that finger **115** which defines a base of the associated cable management opening **120**. In this example, the latch **129** is manually movable to a closed position (shown in FIG. **1**), in which an end of the latch **129** remote from the hinge axis **132** is in snap-latched engagement with a complementary latch recess **135** in the adjacent finger **115** or end unit **123**, as the case may be. The latch **129** can be opened manually by hinged displacement after elastic deformation of the latch **129** to escape the latch recess **135**, to allow insertion or removal into or from the cable management opening **120**. When the latch **129** is closed, cables in the associated cable management opening **120** are held captive against lateral escape, by which is meant that a cable can only be removed from the cable management opening **120** by moving the cable through the cable management opening **120** in the cable's lengthwise direction. But the cable is obstructed from exiting the cable management opening **120** when the cable is moved sideways. In some embodiments, the latch **129** may be biased to its closed position by a spring arrangement.

There are, in this example embodiment, some differences between the double-opening bracket units **106** and the single-opening bracket unit **109**. In particular, the single-opening bracket unit **109** has finger **115** at both its ends, in the example form of a bottom end finger **118** and a top end finger **119**. The single cable management opening **120** defined by the single-opening bracket unit **109** is thus bordered in its entirety by parts of the single-opening bracket unit **109**. Note also that the cable management opening **120** of the single-opening bracket unit **109** is larger than those of the bracket units **103**, in this example being more or less twice the size of the other cable management openings **120**.

The single-opening bracket unit **109** further has an unobstructed hole **143** defined between opposing ends of a prong **140** that projects in the lengthwise direction from the distal end of the bottom end finger **118**, and a truncated lip **142** that projects towards the prong **140** from the distal end of the top end finger **119**. Note that the cable management opening **120** of the single-opening bracket unit **109** is thus not completely enclosed, unobstructed lateral escape by a cable extending through the cable management opening **120** being possible through the hole **143**. Nevertheless, the hole **143** is relatively small in size, allowing transverse passage therethrough of no more than one cable at a time, and is raised relative to a cable support surface provided by the bottom end finger **118**. Inadvertent passage of cables through the cable management opening **120** of the single-opening bracket unit **109**, while being possible, is hindered by the prong **140** and the lip **142**, thus being restrained against lateral escape from the cable management opening **120**.

The bracket units **103** are equal in length, having a common modular length (L) as shown in FIG. **1**. The positions of the bracket units **103** in the series of modular units that together provide the composite bracket **102** are thus interchangeable. Consider, for example, that swapping positions of the single-opening bracket unit **109** and the bottommost double-opening bracket unit **106** in the arrangement of FIG. **6** does not necessitate any change in position or orientation of any of the other bracket units **103** in the composite bracket **102**. Note that the end unit **123** is not considered to comprise a bracket unit **103** as used herein, and that it does not share the common modular length (L).

Modularity and interchangeability of the bracket unit set **100** is promoted by end formations **305**, **306** that are common to all of the bracket units **103**, so that each joint or engagement

between neighboring bracket units **103** in the composite bracket **102** comprises a substantially identical engagement between a bottom end formation **305** of one bracket unit **103** and a top end formation **306** its immediately adjacent, neighboring top end formation **306**. Each bracket unit **103** thus has an engagement formation (e.g., bottom end formation **305**) at one end thereof, and a complementary engagement formation (e.g., top end formation **306**) at its other end, to permit complementary mating engagement of each pair of adjacent bracket units **103** at their adjoining ends. Each of the bracket units **103** has a substantially identical bottom end formation **305**, and each of the bracket units **103** has a substantially identical top end formation **306**, so that any pair of bracket units **103** are compatible for end-to-end mounting on a support structure such as a chassis **607** of an electronic equipment assembly **600**. Note that Such universal connection compatibility between the bracket units **103** of the set **100** promotes interchangeability of the bracket units **103**, so that any permutation or combination of bracket unit sequence is an available and readily implementable option to a user, if a composite bracket **102** having a length equal to the cumulative length of the bracket units **103** in the set **100**. As will be discussed later, the bracket units **103** may also be used to construct any desired composite bracket shorter than that shown in FIG. **1** by omitting one or more of the bracket units **103**. Longer composite brackets **102** may likewise be built by adding one or more identical or compatible bracket units **103**. This may beneficially permit re-use of the bracket units **103** in installations or applications different from that with which they were shipped.

Selected features of the end formations **305**, **306** according to this example embodiment are shown in FIG. **3**. The bottom end formation **305** comprises a cavity in the form of a parallelepipedal niche **310** at a bottom end of the base formation **112** of the associated bracket unit **103**. The bottom end formation **305** thus comprises a stepped formation comprising the niche **310** and a complementary step **315**.

An laterally directed inner face of the step **315** provides a lateral engagement surface **320**.

The top end formation **306** is shaped and dimensioned for complementary mating engagement with the bottom end formation **305** of a neighboring bracket unit **103**. Thus, each top end formation **306** comprises a step **515** (see e.g., FIG. **5**) complementary to the niche **310**, and a niche **510** complementary to the step **315**. The step **515** has a laterally inner face that defines a lateral engagement surface **520** that matches the lateral engagement surface **320** of the bottom end formation **305**.

A laterally extending blind threaded hole **325** open outs of the step **315**, to receive a fastener in the example form of a screw **410** (FIG. **4**). As can be seen in FIG. **3**, the threaded hole **325** is located adjacent to an end of the niche **310** furthest from a rear edge face **364** of the bracket unit **103**. A locating peg **330** projects perpendicularly from the lateral engagement surface **320**.

The top end formation **306** provides to formations that are positioned and dimensioned for cooperation with the threaded hole **325** and the locating peg **330**. First, the a pilot hole **614** extends laterally through the step **515**, being positioned for alignment with the threaded hole **325** in a mating bottom end formation **305**, and opening out of a laterally outer side face of the step **515** in a countersunk opening. The step **515** further defines a laterally extending locating socket **525** in its lateral engagement surface **520**. A mouth of the locating socket **525** is positioned on the lateral engagement surface **520** in a location corresponding to that of the locating peg **330** on the lateral engagement surface **320** of the step **315**. These elements together comprise a fastening arrangement for connecting together the end formations **305**, **306** at each joint that is formed between adjacent bracket units **103**.

Each bracket unit **103** may further comprise a mounting formation to mount the bracket unit **103** on a support structure (e.g., the chassis **607**). In this example, the mounting formation comprises a mounting hole **360** that extends transversely through the base formation **112** that provides a spine of the bracket unit **103**, to permit passage of a threaded fastener such as a bolt or a screw through the mounting hole **360** and into engagement with the support structure on which the bracket unit **103** is mounted. In this example embodiment, the mounting hole **360** thus extends in the depthwise direction of the composite bracket **102**.

Note that each of the example bracket units **103** has only a single mounting hole **360**. In use, a bolt or screw may

The mounting holes **360** are furthermore located at a consistent lengthwise position on the bracket units **103**, so that a distance from the top end formation **306** along the length of the base formation **112** is identical for each of the bracket units **103**, regardless of the number of cable management openings **120** that it provides.

Each mounting formation may further comprise a anchor member to anchor the bracket unit **103** to its support structure against pivoting about a shank of a fastener received in the mounting hole **360**, in use. In this example embodiment, this function is served by a pair of ribs **354** that project from the rear edge face **364** and extend longitudinally along a portion of the side edges of the rear edge face **364**. The ribs **354** define a slot **356** between them for receiving a complementary protrusion or formation on the support structure.

FIG. **6** shows one application of the example bracket unit set **100** in practice. The bracket unit set **100** may be employed to form a cable management bracket **102** for an electronic equipment assembly in the form of an electronic equipment assembly **600**.

The composite bracket **102** may be mounted on a chassis **607** of the electronic equipment assembly **600** such that the composite bracket **102** extends lengthwise alongside a cable interface area **621** of the electronic equipment assembly **600**, providing a longitudinally extending series of cable management openings **120** adjacent one edge of the cable interface area **621**. In this example embodiment, the electronic equipment assembly **600** is defined by an operatively upright rectangular opening in the chassis **607**. The opening is at the rear of the chassis **607** and provides cable access to connection ports of electrical components of the electronic equipment assembly **600**.

In the example embodiment of FIG. **6**, the composite bracket **102** is mounted on the chassis **607** to extend substantially vertically along a lateral side edge of the cable interface area **621**. The lengthwise direction of the composite bracket **102** in the example embodiment of FIG. **6** is thus upright. When thus mounted, the composite bracket **102** extends continuously adjacent the cable interface area **621**, so that there is no gap or omitted bracket units **103** in the series or row of bracket units **103** that together provide the composite bracket **102**.

The composite bracket **102** thus provides a substantially continuous longitudinally extending series of cable management openings **120** that extends alongside the cable interface area **621**. Cables **628** connected to respective connection ports **635** in the cable interface area **621** may be positioned to pass through one of the cable management openings **120**, so that the cable **628** is held in position by the associated bracket unit **103**, lateral escape of the cable **628** from the cable management opening **120** being restricted or prevented by the

bracket unit **103**. To insert a cable **628** into the cable management opening **120** of one of the double-opening bracket units **106**, the cable **628** is latched to the double-opening bracket unit **106** by passing it laterally through the gateway gap **126**. The latch **129** pivots open to allow entry of the cable **628** into the cable management opening **120**, whereafter it is moved back into a latched position, trapping the cable **628** in the cable management opening **120**. Instead, the cable **628** may be threaded through the cable management opening **120**. For the single-opening bracket unit **109**, the cable **628** may be passed laterally through hole **143**.

The operator may arrange the cables **628** so that associated cables **628** extend through a common cable management opening **120**. Often, the electronic equipment assembly **600** may comprise a number of stacked electronic equipment modules **604**. Cables **628** connected to a particular electronic equipment module **604** may in such cases be segregated from other cables **628** by being held together, separate from the other cables **628** by a common bracket unit **103**. In the example embodiment of FIG. **6**, a single composite bracket **102** is mounted on the electronic equipment assembly **600** at a left edge of the cable interface area **621**, but note that, in other embodiments, the cable interface area **621** may be flanked by two composite brackets **102**. A composite bracket **102** may also in some cases be mounted to extend substantially horizontally.

To mount the bracket units **103** on the chassis **607**, thereby to form the composite bracket **102**, an operator may mount the bracket units **103** on the chassis **607** one-by-one in (or out of) sequence. Instead, the bracket units **103** may first be connected together to form the composite bracket **102** separate from the chassis **607**, whereafter the composite bracket **102** may be mounted on the chassis **607**.

In the former instance, each bracket unit **103** is mounted on the chassis **607** by, e.g., sliding the slot **356** (FIG. **3**) downwards to receive a complementary protrusion provided by the chassis **607** or a support structure (such as a mounting bracket) connected thereto. Placement of the slot **356** over its corresponding mounting protrusion on the chassis **607** indexes the mounting hole **360** so that it is in register with a corresponding hole (e.g., a threaded socket) in the chassis **607**. The operator may thereafter pass a fastener through the mounting hole **360** and into the registering support structure hole. Screwing the fastener tight then clamps the base formation **112** to the chassis **607**.

Thereafter, a superjacent bracket unit **103** may be placed in position on the chassis **607** in similar fashion, with the bottom end formation **305** of the newly placed bracket unit **103** in mating engagement with the top end formation **306** of the first-mounted bracket unit **103**. The step **315** of the superjacent bracket unit **103** may thus be received in the niche **510** of its subjacent neighbor, and vice versa for the step **515** and the niche **310** of the respective bracket units **103**.

Such engagement may also comprise inserting the locating peg **330** of the superjacent bracket unit **103** into the complementary locating socket **525**, thus indexing the end formations **305**, **306** and bringing the threaded hole **325** into register with the corresponding pilot hole **328**. The screw **410** is then passed through the pilot hole **328** into the threaded hole **325**, whereafter the screw **410** is tightened to clamp the end formations **305**, **306** together. In this interconnected condition, the lateral engagement surface **320** bears against the lateral engagement surface **520**, so that lateral force interaction between the pair of bracket units **103** may be by operation of the screw **410** and by contact between the surfaces **320**, **520**.

This process may then be repeated for all of the bracket units **103**, thus forming the composite bracket **102**.

As mentioned, the bracket units **103** may instead first be connected together end-to-end by engagement of the end formations **305**, **306** and fastening of the screws **410**. Thereafter, the resultant composite bracket **102** may be positioned on the chassis **607** and may be attached with fasteners passed through the mounting holes **360**.

Note that the example composite bracket **102** mounted on the chassis **607** is attached to the chassis **607** only by the fastener in the example form of a screw **642** passing through the mounting hole **360**. The end-to-end connection of the bracket units **103**, however, serve both to restrict relative lateral movement of the bracket units **103** at their joint (thus restraining pivotal displacement about the mounting hole **360**), and to restrain relative movement of the bracket units **103** in the depthwise direction of the composite bracket **102**, perpendicularly away from the chassis **607**.

Module-specific cable segregation by the composite bracket **102** is facilitated by selection of the modular length (L) of the bracket units **103** such that it a multiple of (or is equal to) a standard unit height for electronic equipment modules. In this example embodiment, the modular length of the bracket units **103** is based on a rack unit (often referred to as U or RU), being a unit of measure used to describe the height of equipment intended for mounting in a 19-inch rack or a 23-inch rack One rack unit is 1.75 inches (44.45 mm) high. The size of a piece of rack-mounted equipment is frequently described as a number in "U". For example, one rack unit is often referred to as "1U" or "1RU," 2 rack units as "2U" or "2RU," and so on. The electronic equipment module **604** of the electronic equipment assembly **600** may comply with this convention, having respective heights measurable in integer RU values.

In this example, the modular length (L) of the bracket unit set **100** is 2RU. The single-opening bracket unit **109** can thus provide a single cable management opening **120** for a 2RU electronic equipment module **604**, while the double-opening bracket units **106** can be used to provide respective cable management openings **120** for a pair of adjacent electronic equipment modules **604**. Note that, in other embodiments, larger or smaller cable management openings may be provided instead, or in addition.

An operator can thus customize the positions of the respective bracket units **103** to correspond to the requirements or configuration of the particular electronic equipment assembly **600**. Because of the bracket unit **103**'s universal modular length and identical complementary end formations **305**, **306**, the bracket units **103** can be arranged in any desired sequence.

Note that a particular bracket unit set **100** may be assembled for use with a corresponding electronic equipment assembly **600**. A manufacturer or distributor may thus sell the electronic equipment assembly **600** together with the custom-selected bracket unit set **100**. A benefit of the modularity of the bracket units **103**, however, is that they may be used in combination with any hardware platform that has a support structure compatible with the mounting formations of the bracket units **103**.

FIG. **7** shows an electronic equipment assembly **600** in accordance with another example embodiment. The electronic equipment assembly **700** is largely similar to the electronic equipment assembly **600** of FIG. **6**, but has a different arrangement of electronic equipment modules **604**. A user may customize the bracket unit set **100** (sold and shipped for use with the electronic equipment assembly **600**) to satisfy with the requirements of the electronic equipment assembly **700**. The example embodiment of FIG. **6** shows a different composite bracket **702** made up of two double-opening bracket units **106**, one single-opening bracket unit **109**, and

the end unit **123**. The type and positioning of the bracket units **103** in the composite cable management bracket **702** is thus selected by the operator to correspond to a chassis **707** and the particular electronic equipment modules **604** of the electronic equipment assembly **700**.

A maker or distributor of electronic equipment may make and sell a range of electronic equipment assemblies, storage equipment (such as server racks), and systems with a common modular standard compatible with the mounting formations of the bracket units **103**. Instead of having to manufacture custom-made brackets for each unique system or equipment arrangement, the manufacturer or distributor may provide modular bracket units **103** for use with all of the equipment in the range of products, by merely selecting the number and type of bracket units **103** that correspond to the respective applications.

A benefit of such broad usability of the modular bracket units **103** is related to economies of scale. Because of the rigidity and strength requirements of cable management brackets, they are often metal parts. To avoid the substantial cost of tooling and manufacturing (e.g., making custom die molds for each unique product's cable management brackets) polymeric plastics brackets have sometimes been employed. These plastics brackets have, in practice, often proven to be prone to failure or premature wear.

For construction of the bracket units **103** as described herein, however, cost considerations associated with cast metal parts are ameliorated by a substantial increase in the number of products in the product range that is serviced by identical bracket units **103**. It is expected, for example, that the double-opening bracket units **106** would form part of respective bracket unit sets of many different products in the range of modularly compatible products. The volume of bracket units produced is thus expected to make the manufacturing and distribution of bracket units **103** that are of cast iron or cast steel economically feasible, if not beneficial, in comparison to, for example, injection molded plastics brackets.

Note also that other, specialized bracket units may be provided for unique applications. Although the cable-management features of such speciality bracket units are not described herein, their modular length (L) and end formations **305**, **306** may be identical to those of the described bracket units **103**, to allow for modular compatibility.

Yet a further benefit of the described example embodiments is that an end user is not limited in the use of the bracket units **103**, as is the case with customized brackets for each unique system. The bracket units **103** can thus be re-used, or bracket units **103** from different original sets can be mixed and matched ad-hoc to meet user needs.

Note further that all of the bracket units **103** have the same depth (due in this example to consistent finger **115** length), so that the bracket units **103** have a consistent form factor (also having the same length (L)). This dimensional consistency promotes free mixing and matching between different sets, while maintaining a unified aesthetic appearance.

Note that the bracket unit set **100** may, in other embodiments, be mounted on support structures other than the chassis **607**. For example, the bracket units **103** may be mounted on a support post forming part of a server rack, thus forming part of a rack installation in which electronic equipment modules can be held in a stacked arrangement.

Although embodiments have been described with reference to specific example embodiments, it will be evident that various modifications and changes may be made to these embodiments without departing from the broader spirit and scope of the disclosure. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

The Abstract is provided to allow the reader to ascertain the nature and gist of the technical disclosure. It is submitted with the understanding that it will not be used to limit or interpret the scope or meaning of the claims. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separate embodiment.

What is claimed is:

1. A composite cable management bracket formed from a set of modular bracket units comprising:

one or more single-opening bracket units that respectively define, when mounted as part of the composite cable management bracket, a single cable management opening, wherein each of the one or more single-opening bracket units comprises a top end stepped formation and a bottom end stepped formation; and

one or more multi-opening bracket units that include a pair of fingers projecting substantially perpendicularly away from a base formation to define, when mounted as part of the composite cable management bracket, two or more cable management openings, the one or more multi-opening bracket units further including at least one latch with a first end hingedly coupled to a distal end of at least one of the fingers and a second end that, when the latch is in a closed position, is in engagement with a finger of another bracket unit coupled to the one or more multi-opening bracket units, and wherein each of the one or more multi-opening bracket units comprises a top end formation and a bottom stepped end formation,

wherein the bottom end stepped formations of the single-opening bracket units and the bottom end stepped formations of the multi-opening bracket units are substantially identical and comprise a niche and an associated step that define a define a first inner face,

wherein the top end stepped formations of the single-opening bracket units and the top end stepped formations of the multi-opening bracket units are substantially identical and comprise a niche and an associated step that define a second inner face,

wherein the niche of the top end stepped formations is complementary to the associated step in the bottom end stepped formations and the associated step of the top end stepped formations is complementary to the niches in the bottom end stepped formations enabling any pair of the single-opening bracket units and the multi-opening bracket units to be mountable end-to-end in series in interchangeable positions where the first inner face of the bottom end stepped formation is engaged with the second inner face of the top end stepped formation, and when any pair of the single-opening bracket units and the multi-opening bracket units are mounted end-to-end, a longitudinally extending series of segregated cable management openings is defined.

2. The composite cable management bracket of claim **1**, wherein the single-opening bracket units and the multi-opening bracket units in the set of modular bracket units have a common modular length.

3. The composite cable management bracket of claim **2**, wherein the common modular length is a whole number multiple of one rack unit (RU).

4. The composite cable management bracket of claim **3**, wherein the common modular length is 2 RU.

5. The composite cable management bracket of claim **1**, wherein the single-opening bracket units and the multi-opening bracket units are shaped and dimensioned such that the

composite cable management bracket has a substantially constant depth dimension transverse to a cable interface area.

6. The composite cable management bracket of claim **1**, wherein the latch is a spring-latch mounted for hinged displacement about a hinge axis on the distal end of the pair of fingers.

7. The composite cable management bracket of claim **1**, wherein each of the single-opening bracket units and each of the multi-opening bracket units includes a mounting formation to effect mounting of the composite cable management bracket on a support structure.

8. The composite cable management bracket of claim **7**, wherein the mounting formations comprise a mounting hole to receive a fastener, and wherein the mounting holes are located at a consistent position along a length dimension of each of the single-opening bracket units and of each of the multi-opening bracket units so that the composite cable management bracket defines a series of mounting holes spaced at a constant interval equal to a modular length common to each of set of modular bracket units.

9. A method comprising:

obtaining one or more single-opening bracket units that respectively define a single cable management opening, wherein each of the one or more single-opening bracket units comprises a top end stepped formation and a bottom end stepped formation;

obtaining one or more multi-opening bracket units that include a pair of fingers projecting substantially perpendicularly away from a base formation to respectively define two or more cable management openings, the one or more multi-opening bracket units further including at least one latch with a first end hingedly coupled to a distal end of at least one of the fingers and a second end, and wherein each of the one or more multi-opening bracket units comprises a top end formation and a bottom end stepped formation,

wherein the bottom end stepped formations of the single-opening bracket units and the bottom end stepped formations of the multi-opening bracket units are substantially identical and comprise a niche, an associated step, and a first inner surface, wherein the top end stepped formations of the single-opening bracket units and the top end stepped formations of the multi-opening bracket units are substantially identical and comprise a niche, an associated step, and a second inner surface, where the niche of the top end stepped formations is complementary to the steps in the bottom end stepped formations and the associated step of the top end formations is complementary to the niches in the bottom end stepped formations;

connecting together opposing top and bottom end stepped formations of a number of the single-opening bracket units and the multi-opening bracket units end-to-end in series in interchangeable positions so that the first inner surface of the bottom end stepped formations engages the second inner surface of the top end stepped formations to form a composite cable management bracket that defines a longitudinally extending series of segregated cable management openings, and wherein the second end of the at least one latch of the one or more multi-opening bracket units is in engagement with a finger of another bracket unit when the at least one latch is in a closed position; and

mounting the composite cable management bracket on a support structure adjacent a cable interface area of an electronic equipment assembly such that the segregated cable management openings are configured to receive cables for connection to respective ports at the cable interface area while being restrained by the composite cable management bracket against transverse escape from the respective cable management openings.

10. The method of claim **9**, wherein the single-opening bracket units and the multi-opening bracket units have a common modular length.

11. The method of claim **10**, wherein the common modular length is a whole number multiple of a rack unit (RU).

12. The method of claim **9**, wherein the latch is a spring-latch mounted for hinged displacement about a hinge axis on the distal end of the pair of fingers.

13. The method of claim **9**, further comprising:

passing a fastener through aligned openings in the cable management bracket, the fastener extending in a direction transverse to both a length dimension and a depth dimension of the composite cable management bracket.

14. The method of claim **9**, wherein the support structure forms part of a chassis of the electronic equipment assembly.

15. A system comprising:

an electronic equipment assembly that has a cable interface area comprising multiple connection ports connectable to respective cables;

a composite cable management bracket mounted on the electronic equipment assembly to extend lengthwise alongside the cable interface area, comprising:

one or more single-opening bracket units that respectively define a single cable management opening, wherein each of the one or more single-opening bracket units comprises a top end stepped formation and a bottom end stepped formation; and

one or more multi-opening bracket units that include a pair of fingers projecting substantially perpendicularly away from a base formation to define, when mounted as part of the composite cable management bracket, two or more cable management openings, the multi-opening bracket units further including at least one latch with a first end hingedly coupled to a distal end of at least one of the fingers and a second end that, when in a closed position, is in engagement with a finger of another bracket unit coupled to the one or more multi-opening bracket units, and wherein each of the one or more multi-opening bracket units comprises a top end formation and a bottom end stepped formation,

wherein the bottom end stepped formations of the single-opening bracket units and the bottom end stepped formations of the multi-opening bracket units are substantially identical and comprise a niche and an associated step that define a first inner surface,

wherein the top end stepped formations of the single-opening bracket units and the top end stepped formations of the multi-opening bracket units are substantially identical and comprise a niche and an associated step that define a second inner surface,

wherein the niche of the top end stepped formations is complementary to the steps in the bottom end stepped formations and the associated step of the top end stepped formations is complementary to the niches in the bottom end stepped formations enabling any pair of the single-opening bracket units and the multi-opening bracket units to be mountable end- to-end in series in interchangeable positions where the first inner surface of the bottom end stepped formations engages the second inner surface of the top end stepped formations, and when any pair of the single-opening bracket units and the multi-

opening bracket units are mounted end-to-end, a longitudinally extending series of segregated cable management openings is defined.

16. The system of claim **15**, wherein each of the single-opening bracket units and each of the multi-opening bracket units is attached to the electronic equipment assembly by a single fastener extending through a mounting hole in the respective bracket unit, the mounting holes being positioned on the respective bracket units such that the composite cable management bracket is attached to the electronic equipment assembly by multiple fasteners spaced along the length of the composite cable management bracket at a regular spacing.

17. The system of claim **15**, wherein the latch is a spring-latch mounted for hinged displacement about a hinge axis disposed on the distal end of the pair of fingers.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,212,765 B1
APPLICATION NO. : 13/720953
DATED : December 15, 2015
INVENTOR(S) : Vic Hong Chia et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

IN THE CLAIMS

In Col. 11, line 45, add "and" after "second inner surface,".

Signed and Sealed this
Twelfth Day of April, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office